Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

7-4.1 Summarize the characteristics of the levels of organization within ecosystems (including populations, communities, habitats, niches, and biomes).
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-2.3), students recalled the characteristics of an organism's habitat that allow the organism to survive there. In 5th grade (5-2.2), students summarized the composition of an ecosystem, considering both biotic factors (including populations and communities).

It is essential for students to know that the levels of organization of the living world include the individual organism, populations, communities, ecosystems, and biomes. Each level is defined by the type and number of organisms or the abiotic factors present.

Populations
- All of the individuals of a given species in a specific area or region at a certain time.
- Members of a population compete for food, water, space, and mates; for example, all of the loblolly pines in South Carolina.

Communities
- All the different populations in a specific area or region at a certain time.
- For example, all of the crabs, seagulls, and sea grass at the beach are part of the same community.
- Communities involve many types of interactions among the populations.
- Some of these interactions involve the obtaining and use of food, space, or other environmental resources.

Ecosystems
- One or more communities in an area and the abiotic factors, including water, sunlight, oxygen, temperature, and soil.

Biomes
- Individual ecosystems grouped together according to the climate and the predominant vegetation and characterized by adaptations of organisms to that particular environment.

Within an ecosystem, organisms have specific places where their needs are met and specific roles within the ecosystem.
- The place where an organism lives in order to obtain its food, water, shelter and other things needed for survival is called its *habitat*.
- The particular role of an organism in its environment including type of food it eats, how it obtains its food and how it interacts with other organisms is called its *niche*. For example, the niche of a bee is to pollinate flowers as it gathers nectar for its food.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

It is not essential for students to know the specific interrelationships among organisms as this will be studied in high school biology, or the characteristics of the different types of biomes on Earth.

Assessment Guidelines:
The objective of this indicator is to *summarize* the characteristics of the levels of organization within ecosystems; therefore, the primary focus of assessment should be to generalize major points about the different levels of organization of the living world as well as habitats and niches in an ecosystem. However, appropriate assessments should also require students to *identify* the individual levels or habitats and niches; *illustrate* the levels using words, pictures, or diagrams; or *classify* by sequencing the levels of organization.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

7-4.2 Illustrate energy flow in food chains, food webs, and energy pyramids.
Taxonomy level: 2.2-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-2.5), students summarized the organization of simple food chains (including the roles of producers, consumers, and decomposers). In 5th grade (5-2.4), students identified the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, considering producers and consumers (herbivores, carnivores, and omnivores), decomposers (microorganisms, termites, worms, and fungi), predators and prey, and parasites and hosts.

It is essential for students to know organisms have energy roles in their environments. Each role is determined by how the organism obtains its energy and how they interact with other organisms in the environment. These roles can be classified as producer, consumer, or decomposer. The flow of energy in an environment can be represented using the following diagrams:

Food chains
- Use pictures or words and arrows to show the movement of energy through the *trophic levels* of organisms.
- The trophic level of an organism indicates the position that the organism occupies in the food chain—what it eats and what eats it.
- The levels are numbered according to how far the particular organism is along the chain from the primary producer at Level 1, to herbivores (Level 2), to predators (Level 3), to carnivores or top carnivores (Levels 4 or 5).

Food webs
- Describe the organisms found in interconnecting food chains using pictures or words and arrows.
- Food webs describe the complex patterns of energy flow in an ecosystem by modeling who consumes whom or what.

Energy pyramids
- Show the amount of energy that moves from one trophic level to another in a food chain.
- The most energy is available at the producer level of the pyramid.
- Energy availability decreases as it moves up the energy pyramid.

It is not essential for students to know how to calculate the amount of energy transferred or lost from one level to another level. Students do not need to know the roles that organisms play in the geochemical cycles (including the cycles of carbon, nitrogen, and water). It is also not essential for students to know the relationships among organisms (including predation, competition, and symbiotic relationships such as parasitism, mutualism, and commensalism) as these topics will be discussed in high school biology.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

Assessment Guidelines:

The objective of this indicator is to *illustrate* energy flow in food chains, food webs, and energy pyramids; therefore, the primary focus of assessment should be to give examples of how energy flows in food chains, food webs and energy pyramids. However, appropriate assessments should also require student to *identify* the roles that organisms serve in food chains, food webs and energy pyramids; *illustrate* food chains, food webs, and energy pyramids using words, pictures, or diagrams; *recognize* the trophic levels found in food chains, food webs, and energy pyramids; or *summarize* the roles that organisms play in a food chain, food web, or energy pyramid.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-2.4), students explained how changes in the habitats of plants and animals affect their survival. In 5th grade (5-2.5), students explained how limiting factors (including food, water, space, and shelter) affect populations in ecosystems.

It is essential for students to know that there are various factors that can change the environment. These factors, which include natural hazards, changes in populations, and limiting factors, all have similar effects on the environment, and can affect each other. These changes can have an effect on the amount of resources available in the environment. This can lead to competition for food, water, space, or shelter.

Changes in the environment can occur due to *natural hazards*.
Landslides

- Landslides are large areas of ground movement of rock, earth, or debris that fall, slide, or flow on slopes due to gravity.
- They can occur in any environment given the right conditions of soil, moisture, and the angle of slope.
- Landslides can be caused by rains, floods, earthquakes, and other natural causes, as well as human-made causes such as excessive development or clear-cutting for lumber.
- Some examples of ways that landslides can effect the environment are blocking roads, damaging or destroying homes, destroying habitats, or disrupting power lines.

Wildfires

- Fire is a natural event in most grassland and forest ecosystems.
- Fires can be beneficial to the ecosystem and are an essential component in the life cycle of some trees.
- Generally, fires are neither good nor bad. They occur naturally through lightning strikes or when humans start them accidentally or intentionally.
- Some examples of the effects of wildfires on the environment are: ability of some seeds to break open so they can germinate, an increase in air pollution, habitat destruction, or destroying homes or property.

Floods

- A flood is an unusually high water stage in which water overflows its natural or artificial banks onto normally dry land.
- There are two basic types of floods.
  - In a regular river flood, water slowly climbs over the edges of a river.
  - The more dangerous type, a flash flood, occurs when a wall of water quickly sweeps over an area. Some examples of factors that contribute to flooding are

  - heavy, intense rainfall
  - over-saturated soil (when the ground cannot hold anymore water)
  - high river, stream or reservoir levels caused by unusually large amounts of rain
  - urbanization, or lots of buildings and parking lots
- Some examples of the effects of floods on the environment may include damaging property, endangering humans and animals, or causing soil erosion and deposition of sediment and nutrients and creation of fertile soil.

Changes in the environment can occur due to *changes in populations*. Changes in populations can occur when new members enter a population or when members leave a population. This will have an effect on the *population density* (the number of organisms in the given amount of space) for a particular area.

Births and Deaths
- New births are the main way that organisms are added to a population.
- The number of births in a population during a certain amount of time is called the *birth rate*.
- Deaths are the main way that organisms leave a population.
- The number of deaths in a population during a certain amount of time is called the *death rate*.

Immigration & Emigration
- The size of the population can change when members move into or out of the population.
- *Immigration* is when organisms move in from another environment.
- When part of the population leaves the environment, this is known as *emigration*.

Changes in the environment can occur due to *limiting factors*. These limiting factors can affect the number of organisms an environment can support. The maximum number of organisms that can survive in a particular ecosystem is known as the *carrying capacity*.

Climate
- Climate refers to the temperature and amount of rainfall in a particular environment. Changes in temperature and the amount of rainfall from what is normal for that area can change an environment, which will have an effect on the populations in the area.

Availability of food, water, space, and shelter
- Organisms require a certain amount of food water, space, and shelter in order to survive and reproduce.
- When the availability of the amount of any of these resources in a given area is less than what the various populations need, it becomes a *limiting factor*.
- When plants and animals compete for these resources, some will get them and some will not.
- Those that get the resources survive. Those that do not, will move to where the resources are available or die.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

It is not essential for students to know how the interrelationships of organisms create stability in an environment, ecological succession, characteristics of specific climate regions (biomes), or how human activities affect the environments.

Assessment Guidelines:
The objective of this indicator is to *explain* the interactions among changes in the environment; therefore, the primary focus of assessment should be to construct a cause-and-effect model of the various ways that natural hazards, changes in populations, and limiting factors affect the environment. However, appropriate assessments should also require students to *exemplify* ways that the landslides, wildfires, and floods affect the environment; *compare* ways in which population sizes can change; *summarize* how the availability of resources can affect a population; or *recognize* changes in the environment as due to a natural hazard, population changes, or limiting factors.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

7-4.4 Explain the effects of soil quality on the characteristics of an ecosystem.
Taxonomy level: 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade (1-4.3), students recognized the composition of Earth including rocks, sand, soil, and water). In 3rd grade (3-3.1), students classified soils (including humus, clay, sand, and silt) on the basis of their properties. The properties of soil quality are new material for this grade.

It is essential for students to know that soil is one of the most valuable abiotic factors in an ecosystem because everything that lives on land depends directly or indirectly on soil.

- This will have an effect on the types of plants that can grow in an ecosystem, which directly impacts the types of other organisms that can survive there.
- Should soil quality change in any of its properties, the ecosystem (including life forms) will also change.

Soil quality is based on properties that can be observed such as soil profile, composition, texture, or particle size.

Soil profile

- Soils form in layers, or *horizons*, and all the layers make up the *soil profile*.
- A mature soil profile consists of three layers – topsoil, subsoil, and parent material above bedrock.
- Topsoil that is nutrient rich, containing a mixture of humus, clay, and minerals, is most suitable for plant growth.
- Most animals live in the topsoil horizon.

Composition

- Soil is a mixture of rock particles, minerals, decayed organic material, air, and water.
- The decayed organic matter in soil is *humus*.
- The sand, silt, and clay portion of soil comes from weathered bedrock material.
- The combination of these materials in soil determines the soil type and affects the types of plants that can grow in it or animals that can live in it.
- Factors that may affect soil type are the types of plants, climate, time, and slope of the land.

Texture

- Soil texture depends on the size of individual soil particles and is determined by the relative proportions of particle sizes that make up the soil.
- Texture names may include loam, sandy clay loam, silt loam, or clay depending upon the percent of sand, silt, and clay in the soil sample.
- The texture affects the amount of water that can be absorbed for use by plants and animals.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

Particle size

- Soil particles are classified by size ranging from coarse sand to very fine sand to silt, and finally to the smallest particle, clay.
- Soil particles that are larger than 2mm are called *gravel*.
- Particle size also affects the amount of water that can be absorbed and used by plants and animals.

Soil quality is also based on properties that can be measured, such as permeability and pH.

Permeability

- Soil particles have open spaces (*pores*) between them that let water flow through.
- How freely that water flows is the permeability of the soil.
- The closer the particles pack together because of particle size, the less permeable the soil is.
- Measuring permeability involves calculating the rate of drainage.

pH

- Soils can be basic or acidic and usually measure 4-10 on the pH scale.
- Indicators can be used to measure the pH of soils.
- Most plants grow best in soils with a pH of between 5 and 7.
- Regardless of the nutrients present in the soil, if the pH is not suitable those nutrients will be inaccessible to the organisms.
- Lime is a kind of fertilizer that alters pH and making the soil nutrients more accessible.

It is not essential for students to measure soil temperature or moisture content (although these are other factors that influence soil) or the factors that affect soil formation. The specific grain size for soil particle classification is not essential. Students do not need to identify or evaluate conservation methods to protect soils but a discussion on this topic may be appropriate to emphasize the importance of soil.

Assessment Guidelines:

The objective of this indicator is to *explain* the effects of soil quality on the characteristics of an ecosystem; therefore, the primary focus of assessment should be to construct a cause-and-effect model of properties of soil quality and how the ecosystem is enhanced by those qualities or how the ecosystem changes should a quality or several qualities change. However, appropriate assessments should also require students to *illustrate* a soil horizon using words, pictures or diagrams; *identify* the component parts of soil; *infer* the soil qualities that affect the amount of water soil can hold; *infer* what might happen to an ecosystem should a particular soil quality change; *classify* by sequencing soil particle sizes; *identify* a method for observing or measuring a soil quality; or *recognize* a soil quality based on its description.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

7-4.5 Summarize how the location and movement of water on Earth's surface through groundwater zones and surface-water drainage basins, called watersheds, are important to ecosystems and to human activities.
Taxonomy level: 2.4-B Understand Conceptual Knowledge

Previous/Future knowledge: In 1st grade students recognized water as part of the composition of Earth (1-4.1) and recognized the property that water will flow downhill (1-4.4). In 3rd grade Earth's water, saltwater and freshwater, features were identified and illustrated (3-3.2) and weathering, erosion, and deposition (by water) were illustrated as slow processes that change Earth's surface (3-3.8). During the study of the water cycle in 4th grade (4-4.1), runoff of water was identified as part of the process. High school Earth Science will continue the study of the movement of water on Earth's surface (ES-5.1) and illustrate the succession of river systems (ES-5.2). Karst topography as a result of groundwater processes is also in high school Earth Science (ES-5.3)

It is essential for students to know where water is, how it moves, and why it is important as an abiotic factor within an ecosystem. When water falls to Earth, some water soaks into the ground becoming part of groundwater. Gravity causes some of it to flow downhill as surface water instead of soaking into the ground; this is called *runoff*.

Groundwater

- Water that soaks into the ground. Soil and rock that allow the water to pass through is called *permeable*.
- The water enters into the *zone of aeration*, which is unsaturated. Groundwater will keep moving deeper into Earth until it reaches a layer of rock that is not permeable.
- The area where the water has filled all the space in the soil is called the *zone of saturation*; the top of this zone is the *water table*.
- Groundwater can also flow slowly through the underground rock or be stored in underground layers called *aquifers*.
- Groundwater is naturally purified as it soaks through the soil layers.

Surface-water

- Runoff that has not soaked into the ground. As runoff travels downhill, it forms the water in streams and rivers.
- An area that is drained by a river and all the streams that empty into it, the tributaries, is called a *drainage basin* or *watershed*.
- A *divide* is the high ground between two drainage basins.
- By studying a map that contains rivers and marking all the tributaries of that river, the watershed area can be identified.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

The availability of water as groundwater or surface-water is important to the ecosystems in that area. Some examples are:

- Flowing water can erode the land in one location and deposit the sediments in another.
- The floodplain of a river may deposit sediment after heavy rains enriching the area with new soil needed for growing vegetation. This new soil is nutrient rich. Crops or natural vegetation grow well in it.
- The drainage basin provides the needed water for animal life also.
- Deltas may form where the river ends its journey into a still body of water like a lake or the ocean. A unique ecosystem forms in delta regions, like the Santee delta in South Carolina or the Mississippi delta in Louisiana.

Water is also important to human activities. Some examples are:

- Human beings are dependent upon water for survival, not only for drinking but for agriculture and industry as well.
- Dams have been placed along some rivers in order to produce hydroelectric power and to offer recreation in the lakes that form behind the dams.
- Lakes, rivers, and the ocean contain sources of food and minerals.
- Earth is 71% water with 3% freshwater. Since much of the freshwater is in the form of ice, very little is left as "usable" freshwater for humans.

It is not essential for students to know the development of river systems or the features that form along river systems. Students do not need to know about springs, geysers, or the different types of wells or how they function to provide water. Karst topography and the formation of deposits in caves or sinkholes are also not necessary. Glaciers, their movement and deposits, are not part of this indicator.

Assessment Guidelines:
The objective of this indicator is to *summarize* how the location and movement of water on Earth's surface are important to ecosystems and human activities; therefore, the primary focus of assessment should be to generalize major points about groundwater and surface-water and their importance to ecosystems and human activities. However, appropriate assessments should also require students to *compare* groundwater and surface water; *interpret* a diagram of groundwater zones; *illustrate* a drainage basin on a map; or *exemplify* ways that humans use water.

Ecology: The Biotic and Abiotic Environment

7-4 The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environments. (Earth Science, Life Science)

7-4.6 Classify resources as renewable or nonrenewable and explain the implications of their depletion and the importance of conservation.
Taxonomy level: 2.5 and 2.7-B Understand Conceptual Knowledge

Previous/Future knowledge: Students in the elementary grades studied various Earth materials that have useful purposes. In 5th grade (5-3.6), students explained how human activity such as conservation efforts and pollution has affected the land and the oceans of Earth. The concept of resources being renewable or nonrenewable is new content for this grade.

It is essential for students to know that all organisms on Earth, including humans, use resources provided by the environment. Earth supplies a variety of *natural resources* that living things use, change, and reuse. Some resources can be replaced and reused by nature; these are *renewable* resources. Natural resources that cannot be replaced by nature are *nonrenewable*.

Renewable resources are replaced through natural processes at a rate that is equal to or greater than the rate at which they are being used. Air, freshwater, soil, living things, and sunlight are renewable resources.

- Air can be cleaned and purified by plants during the process of photosynthesis as they remove carbon dioxide from the air and replace it with oxygen.
- The water cycle allows Earth's water to be used over and over within the environment.
- Topsoil is formed to replace soil that has been carried away by wind and water (although new soil forms very slowly).
- Trees and other new plants grow to replace those that have been cut down or died.
- Animals are born to replace animals that have died.
- Sunlight, or solar energy, is considered a renewable resource because it will continue to be available for billions of years. It provides a source of energy for all processes on Earth.

Nonrenewable resources are exhaustible because they are being extracted and used at a much faster rate than the rate at which they were formed.

- Fossil fuels (coal, oil, natural gas), diamonds, metals, and other minerals are nonrenewable.
- They exist in a fixed amount and can only be replaced by processes that take millions of years.

Natural resources can be depleted or used to the point that they are no longer available. Conservation measures are necessary for nonrenewable resources because they are known to be in a non-replenishing supply. If renewable resources are used at an increasing rate so that they cannot be naturally replaced fast enough, they too can be depleted.

- Soil that is lost because it is left bare of vegetation and allowed to erode depletes the land of the fertile topsoil needed for plant growth in that area.
- Depletion of freshwater in an area caused by increased demand by the population living there, by wasteful use of the water, or by pollution, can result in water not being available in needed quantities or being unfit for natural use.

- Depletion of a living resource, such as trees being removed without being replanted, can contribute to environmental changes in the land, air, and water in that area.

As the number of people on Earth gets larger, the need for natural resources increases. The terms reduce, reuse, recycle and protect are important ways that people can be involved in conservation of natural resources.

- *Reducing* involves making a decision to not use a resource when there is an alternative, such as walking or riding a bicycle rather than traveling in a car.
- *Reusing* involves finding a way to use a resource (or product from a resource) again without changing it or reprocessing it, such as washing a drinking glass rather than throwing away plastic or Styrofoam.
- *Recycling* involves reprocessing a resource (or product from a resource) so that the materials can be used again as another item, such as metals, glass or plastics being remade into new metal or glass products or into fibers.
- *Protecting* involves preventing the loss of a resource, usually living things, by managing their environment to increase the chances of survival, such as providing wildlife preserves for endangered animals.

It is not essential for students to know how human consumption of natural resources affect the physical and chemical cycles and processes of Earth, as this is a topic that will be further developed in high school biology.

Assessment Guidelines:
The objective of this indicator is to *classify* natural resources as renewable and nonrenewable; therefore, the primary focus of assessment should be to determine a category based on the description of the natural resource. However, appropriate assessments should also require students to *exemplify* natural resources that are either renewable or nonrenewable; or *summarize* ways that natural resources are renewed.

Another objective of this indicator is to *explain* implications of depleting or conserving natural resources; therefore, the primary focus of assessment should be to construct a cause-and-effect model of depletion and conservation of resources. However, appropriate assessments should also require students to *summarize* major points about Earth resources and the importance of conservation; *infer* effects of the depletion of a resource; or *recall* ways that conservation can be accomplished.